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USING BENEFIT-COST ANALYSIS IN PLANNING AND EVALUATING VOCATIONAL EDUCATION.

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BASIC ELEMENTS INVOLVED IN ANALYSIS BY RATIONAL RESOURCE ALLOCATION ARE APPLIED TO VOCATIONAL EDUCATION. TO IMPROVE THE EFFICIENCY OF USE OF ALLOCATED RESOURCES, THE RELATIONSHIPS BETWEEN APPLICATION OF RESOURCES TO A PARTICULAR PROGRAM AND ATTAINMENT OF OBJECTIVES CAN BE DETERMINED BY BENEFIT-COST ANALYSIS. THE RATIO OF THE PRESENT VALUE OF FUTURE BENEFITS TO THE PRESENT VALUE OF FUTURE COSTS. COSTS AND BENEFITS OF PARTICULAR VOCATIONAL PROGRAMS MUST BE ANALYZED FROM THE VIEWPOINTS OF BOTH THE INDIVIDUAL STUDENT AND SOCIETY. THE DERIVED RATIOS ARE THE SOCIETAL BENEFIT-COST RATIO OF A PROGRAM. A VARIATION OF BENEFIT-COST ANALYSIS TREATS BENEFITS AS AN UNKNOWN IN AN EQUATION INCLUDING KNOWN COSTS, NUMBER OF STUDENTS, AND AN ARBITRARILY SELECTED BENEFIT-COST RATIO. SOME LIMITATIONS OF USING BENEFIT-COST ANALYSIS FOR EVALUATING VOCATIONAL EDUCATION AND AS A BASIS FOR MAKING PUBLIC EXPENDITURE DECISIONS IN THE FIELD ARE--(1) DIFFERENT PEOPLE HAVE DIFFERENT MONEY VALUES SO THAT WHAT IS DOLLAR VALUE TO ONE MAY NOT BE TO ANOTHER, (2) THE SEARCH FOR THE BEST POSSIBLE PROGRAMS IS LIMITED TO ONLY THOSE PROPOSED, (3) IT IS DIFFICULT TO ASSESS THE VALUE OF INTANGIBLE BENEFITS WHICH CANNOT BE MEASURED IN DOLLAR TERMS, AND (4) CONSIDERING PROGRAM VALUE FROM ONLY A LOCAL VIEWPOINT MAY RESULT IN MAINTAINING OR REJECTING ONE IN CONFLICT WITH THE AGGREGATE OR NATIONAL INTEREST. DESPITE POSSIBLE LIMITATIONS, USE OF BENEFIT-COST ANALYSIS APPEARS DESIRABLE IN EVALUATING AND PLANNING VOCATIONAL EDUCATION AT THE STATE AND LOCAL LEVELS BECAUSE IT IDENTIFIES CURRENT OR PROPOSED PROGRAMS IN WHICH PROBABLE ECONOMIC BENEFITS DO NOT JUSTIFY THE ACTUAL OR PROSPECTIVE EXPENDITURES. THE APPENDIX CONTAINS A PRECISE FORMULATION OF THE BENEFIT-COST ANALYSIS METHODS. (WB)

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USING BENEFIT-COST ANALYSIS IN PLANNING AND EVALUATING VOCATIONAL EDUCATION

A Paper Prepared For

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Economists have long been concerned with the way in which resources are allocated via market mechanisms to satisfy competing and unlimited consumer wants, recognizing that some wants must be satisfied through the public rather than private sector of an economy such as that in the United States. In recent years, particularly since the end of World War II, economists have been active in developing analytical techniques for allocating resources within the public sector. The two most notable areas where these techniques have been applied are in the field of water resources - the use of benefit-cost analysis in evaluating irrigation, flood control, hydro-electric and other investment projects - and in the Department of Defense - the use of the planning, programming, budgeting system to achieve effective management. President Johnson has recently called for the extension of these techniques throughout the Federal government.

In this paper the possibility of using benefit-cost analysis in planning and evaluating vocational education is explored. In the first section the basic elements involved in the analysis of any government program from the point-of-view of rational resource allocation are presented. In the second section these basic elements are discussed in the context of vocational education. Throughout the paper the term vocational education will be used to refer to that part of a student's instruction intended specifically to fit the student for work, i.e. all formal instruction for both youth and adults, at the high school, post-high school, and out-of-school level, which prepares individuals for initial entrance into and advancement within an occupation or group of related occupations but does not lead directly to a baccalaureate or professional degree.* In the third section benefit-cost analysis is explained in some detail as it might be applied to evaluating and planning vocational education. That discussion will be kept as non-technical as possible - a more precise formulation is presented in the Appendix. In the fourth and final section the limitations of using benefit-cost analysis as a method of evaluating vocational education and as a basis for making public expenditure decisions in the field of education are explored.

I

THE BASIC PRINCIPLES OF RESOURCE ALLOCATION WITHIN THE PUBLIC SECTOR

There is nothing inherently mysterious about benefit-cost analysis, systems analysis, operations research, or any of the other analytic techniques which have been developed in recent years and used by some government agencies in developing and evaluating their programs. The expertise required to understand these types of analysis is minimal; the amount required to use and develop such techniques is, in the vast majority of cases, limited to a good introductory college

*This definition is taken from: Report of the Panel of Consultants on Vocational Education, Education for a Changing World of Work, GPO, Washington, D.C., OE 80021, 1964.

level course in economics, high school algebra, and in some cases an elementary knowledge of statistics. In essence a government is thought of as similar to a family which is faced with unlimited opportunities for spending money but which has only a limited amount to spend. Just as a family considers the relative advantages of spending less on this in order to spend more on that, a government should consider the losses implied by spending less in one area and the gains from additional spending in another area. Just as a family never stops to consider the total satisfaction which it receives from food but nevertheless may well ponder the results of spending $10 less on groceries and $10 more on entertainment, a government, in the broadest sense of the totality of political processes, may never consider the total value of defense or medical research. But the decision to "buy" an extra army division or spend an additional $100 million for cancer research is certainly subject to analysis. Just as no family ever reaches an optional position where the last dollar spent on each item of consumption yields the same increment to total family welfare, a government never reaches the position where no possible reallocation of expenditures among programs would yield extra benefits (or where no reallocation of resources between the public and private sectors would yield an improvement). Since the affairs of government are infintely more complicated than those of a family the process of resource allocation within the public sector usually takes place within the confines of particular program areas like defense or education. Sometimes the relationships between program areas can only be overlooked at considerable risk; for example, the statistical relationship between expenditures for education and draft rejection rates suggests an area for analysis which overlaps traditional program areas. The first step in analyzing a program area is to specify the objectives of the program.

Specifying Program Objectives:

To reduce the extent to which program objectives are regarded as intangible, goals should be specified in a quantifiable manner. For many this first step may be a leap of faith - how, it is asked, can health, or education, or welfare be quantified. Certainly in not every case will it be possible to quantify program objectives, but it has been the experience of some government agencies, particularly the Department of Defense, that objectives which at first appear entirely intangible, are, after due thought and analysis, subject to quantification. The objectives of health programs could be quantified in terms of the incidence of desease or the recovery rate; the objectives of a high school might be quantified in terms of the differences between pupil test scores on entrance and upon graduation. Much care has to be given to the quantification of program objectives. For example a high school which takes as its objective maximizing the test scores of its graduate could do so by using a program to which poorer students would not respond and from which they would be likely to drop out (or be pushed out) and which catered to those students who would get high test scores. Specifying the objective in terms of the difference between beginning and ending test scores would be more relevent and might well dictate a different kind of high school program. Indeed a

beneficial side effect of the attempt to quantify program objectives is the rethinking of goals which such an effort stimulates.

Listing the Alternatives:

Once program objectives, both the quantifiable and the intangible, have been specified alternative methods of meeting those objectives should be listed. Alternatives may present themselves in the form of various existing programs directed toward the same objective. Care should be taken not to exclude alternatives which are outside the traditional sphere of a particular agency. For example, an agency which has authority to build flood control projects may consider alternative of flood plain zoning, which would legally prevent the construction of buildings in a potential flood area, because that alternative is outside its jurisdictional purview.

Marginal Analysis - Meeting Objectives and Costs:

The concept of marginal analysis is central to any formalized attempt to evaluate a particular existing or proposed program. Seldom is it relevent to ask what is the total contribution a program makes toward the achievement of the specified objective. More generally the comparison should be made between an additional expenditure for the program (or a reduction of a given amount) and the resulting increase (or decrease) in the quantitatively expressed program objective. Diminishing marginal returns are pervasive. Everyone would agree that the value of the first few billions of dollars spent on education is very high; but it is also obvious that after some point an additional billion dollars contributes less toward meeting educational objectives than the preceeding billion dollars. Similarly everyone would agree that having a few polaris submarines creates an effective deterrent force yet clearly one more polaris submarine will contribute less to total deterrence than the last one which was launched. The question then is how much a marginal program element (e.g., an additional high school course, and additinnal submarine, or an additional ten feet of height on a dam contributes toward the measurable program objective (e.g., the difference between entering and graduating pupil test scores, the probability of target distruction, or the probability of preventing a certain dollar amount of flood danage).

The second aspect of marginal analysis is the identification of the total cost of a program element over its entire life including the cost of supporting activities. In the case of the additional high school course there may well be the capital cost of an extra classroom in additiona to supplies and teacher salaries. The cost of teacher training should also be considered if these are borne by the public. The submarine will require support facilities at some port, training expenses etc. The cost of an additional ten feet in the height of the dam may include, in addition to construction costs, the value of additional farm land which will be inundated by the large resevoir. A rational decision can only be made after marginal gains and costs have been calculated.

The cost of an additional program element is usually not obvious from the budget and accounting records of public agencies. These documents typically list expenditures in terms of object categories-salaries, interest payments, maintenance costs, and the like - rather than specifying expenditures for a particular program element. (The problem of identifying the costs of program elements in the field of education seems quite similar to that faced by those, like the staff members of the RAND Corporation, who attempted to develop an analytical approach to military expenditures after World War II.)

The Element of Time:

In many cases both the gains from and the costs of a marginal program element accrue over long periods of time. Whenever the element of time enters into the analysis future gains or costs must be discounted in making any comparison with current magnitudes. A dollar of future gain is always worth less than a dollar at the moment and a gain of a comparable absolute amount is always worth more in the near future than in the more distant future. This is true because one dollar today can be invested (say put in a savings account) so that the value of the investment will be more than a dollar in the future. (At a time t years into the future the value of the dollar invested today is equal to $1 \times (1 + i)^t$, where i is the rate of interest. A dollar amount t years in the future must then be discounted (multiplied) by a factor equal to $1/(1 + i)^t$.)

The Final Decision:

Once the quantitative relationship between the program goal and a marginal program element is specified the appropriate decision does not follow automatically. In the cases where objectives can be quantified in dollar terms the decision may be more clear cut but the usual case will be where the decision maker has to ask whether the additional gain is worth the additional cost - is it worth the x millions dollars which an additional military unit costs in order to raise the probability that certain targets can be destroyed from 80 to 90 percent or is it worth y million dollars to reduce the high school dropout rate from 40 percent to 30 percent. At this point intangible factors reapear in the analysis as an influence in the process of making the final decision. Those charged with responsibility for making the final decision should have several alternatives before then all of which would increase the probability of target destruction from 80 to 90 percent or reduce the dropout rate from 40 to 30 percent. Each alternative would involve certain known costs but might be sorrounded by a different mix of intangible factors.

II

VOCATIONAL EDUCATION AND THE ALLOCATION OF RESOURCES WITHIN THE PUBLIC SECTOR

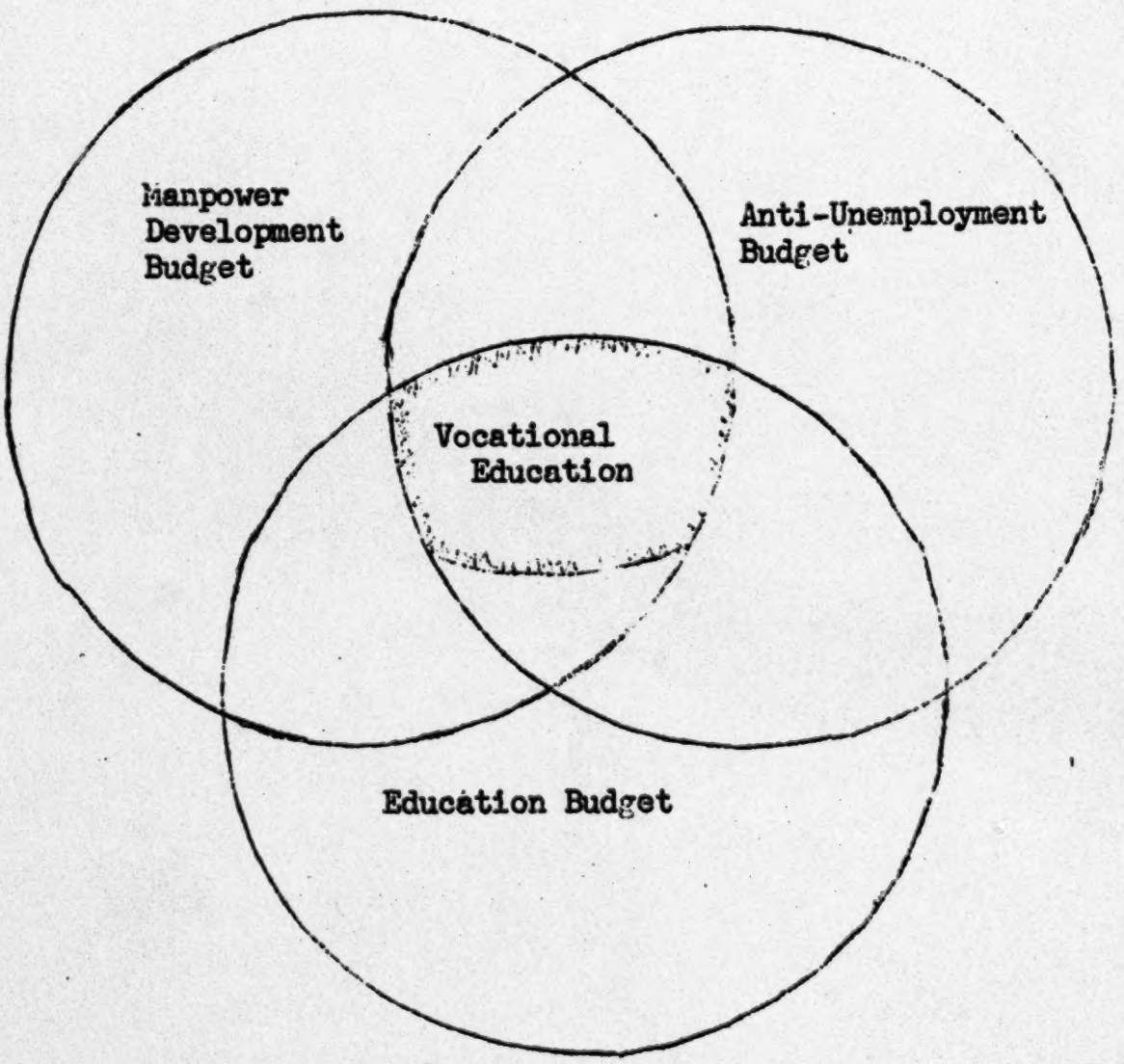
If vocational education is viewed in the context of the general principles of resource allocation within the public sector as outlined

above a variety of approaches are possible. The particular approach taken depends on the manner in which the objectives of vocational education are specified which in turn will limit the range of alternatives to be considered.

Objectives and Alternatives:

What follows in this section is not meant to be an exhaustive treatment of the objectives of vocational education or the possible alternatives to vocational education, as defined above (p.1). The intention is to provide an example of this approach to the problem of resource allocation within this public sector.

Vocational education may be thought of as directed toward increasing the productivity of the labor force, as directed toward minimizing the rate of unemployment, or as directed toward general educational objectives of individual betterment. These three possible objectives can be illustrated by the diagram below:



If the objective of vocational education programs is thought of as increasing the productivity or earning potential of the labor force these programs would then be a part of what might be called the public sector's Manpower Development Budget. Within this budget would be other programs such as job retraining, subsidized on-the-job training, Job Corps, etc., all of which are directed toward that objective and which could be thought of as alternatives to vocational education. The objective of resource allocation within the Manpower Development Budget would be to achieve the best mix of these programs, the mix which maximizes the resulting increase in labor productivity or earning potential given the amount of funds devoted to this portion of the total public expenditure budget. (For the purposes of this paper the problem of determining what portion of the total public expenditure budget to allocate to Manpower Development will be ignored.)

If the objective of vocational education is thought of as reducing the degree of unemployment vocational education could then be considered as one element in the public's Anti-Unemployment Budget, though the latter would include such items as public works programs and fiscal and monetary policy which would not be included in the former. The problem of allocation within the Anti-Unemployment Budget would be to achieve the mix of expenditures for specific programs which would achieve the greatest reduction in the rate of unemployment given the funds made available to that Budget.

The third approach is to consider vocational education as a part of the total Education Budget directed toward individual betterment. Allocation within this budget is beset by the difficulties involved in deriving quantiative measures of "individual betterment." While this subject is outside the scope of this paper one suggestion can be made for coping with this aspect of the problem. Alternative educational programs might be judged in terms of the differences between test scores of students entering the programs and their test scores upon completion of the program. A quantitative measure of this sort avoids differences in student performance due to diverse ability levels by concentrating on charges in rather than absolute levels of performance, i.e. concentrating on the difference between the raw material going into an educational program and the finished product. A measure like this could be used to select the best programs in a particular area of education and thereby improve the efficiency with which educational resources are used. Again some programs in the Education Budget are also in the Manpower Development and/or the Anti-Unemployment Budget.

Marginal Analysis:

To improve the efficiency with which resources are used in any one of these three budgets the relationship between the application of resources to particular programs and the attainment of the specified objectives must be examined on the margin. It will seldom be appropriate to ask what the total contribution of a particular program is to labor productivity, or reducing the rate of unemployment, or individual betterment. Rather the question will be, would objectives be better served if X million dollars were moved from one program to another within a budget. If, with the passage of time, increasing

amounts become available for allocation within any one budget the question involves selecting from among the various programs those in which additional expenditures will contribute most toward the objectives of the particular budget.

Any one government agency will control programs in only a part of any one of the three budget areas described above. In addition responsibility for programs of some types, like vocational education, will be shared by many units of government, Federal, State, and local. This creates institutional impediments to analytical comparisons on the margin between certain programs within a budget area. A first step to be taken in the effort to improve the allocation of resources within the public sector is to apply analysis to the area of expenditures which is within the control of a particular agency. In terms of the diagram on page 5, one can think solely of the vocational education budget and the possibility of improving the efficiency of resources already devoted to vocational education. By confining the analysis to a more restricted area some opportunities for gross improvements in efficiency may be overlooked but as an initial step it has the advantage of conformity to existing institutional arrangements and permits simpler methods of analysis to be used. The third section of this paper contains a discription of the basic elements of benefit-cost analysis and a discussion of how benefit-cost analysis might be used to improve the efficiency of resources devoted to vocational education.

III

BENEFIT-COST ANALYSIS

Benefit-cost analysis is an analytical technique, first developed for use in evaluating water resources projects, which explicitly deals with time. Benefits from a public expenditure program are likely to accrue over time in a particular pattern; the costs of such program will probably have a different time pattern. To make a comparison of costs and benefits it is necessary to develop single dollar amounts which summarize streams of benefits or costs overtime. (See the Appendix for a more formal statement of benefit-cost analysis.) These single dollar amounts are derived by discounting dollar amounts of either cost or benefit which accrue in each future year and summing up the resulting figures; they are often referred to as the present value of the future stream of benefits or costs. The ratio of the present value of future benefits to the present value of future costs is in termed the benefit-cost ratio. Unless the benefit-cost ratio for a particular project is greater than one, that is, unless the present value of future benefits is greater than the present value of current and future costs, that project should not be undertaken (barring extensive intangible benefits which could not be included in the formal analysis). The higher the ratio of benefits to costs the more desirable the project. As a first step in examining the possible application of benefit-cost analysis to vocational education the decision of a single individual whether or not to enroll in a particular program of vocational education can be examined.

The Individual's Evaluation:

An individual may be thought of as comparing the future financial benefits from a particular educational program with the costs involved. Once the student is past the age of mandatory school attendance he makes a series of such comparisons, though of course other considerations are involved some of which may even be of more significance. While few if any students explicitly subject their decisions to benefit-cost analysis the case none the less serves as an introduction to the subject and is not without some valuable insights.

Suppose a student is considering whether or not to enroll in a program of vocational education. The benefit as he sees them will be additional dollars of income earned, net of taxes, as a result of the training he receives. The present value of the future additional income can be calculated. The interest rate used in such a calculation may be quite high if the individual attaches a very high value to current as opposed to future income. The costs of the program are of two types: out-of-pocket expenses and opportunity costs. If the student enrolls in the program he may have to pay tuition and fees, transportation costs, and other items associated with the schooling. In addition he has to forego the income which could have been received had he been employed rather than in school; this is the opportunity cost of education and generally it increases as the level of education increases. The present value of the future additional income is then compared with the sum of these costs (assume that the program only lasts one year to avoid the necessity of discounting future costs). If the ratio is greater than one the student would be willing to enroll in the program if no other program presents itself which has a higher ratio. Much of vocational education is bought and sold in the private sector where students bear the full cost of the training charged by the selling institution and in some presumably implicit fashion reason that the benefits to them in terms of future income more than compensate for the cost. The student who does not have the ready cash to cover the costs of the program may go to the capital market and borrow; on a theoretical level, the source of the funds does not effect the decision, though as a practical matter lenders may not respond to such a request. Surely other factors enter into these decisions and may even result in some students enrolling in programs where the ratio of the present value of the future additional income to the cost is less than one - e.g., the girl who goes to secretarial school with the expectation of someday marrying the boss.

Benefits and Costs as Seen by Society:

Benefit-cost analysis could be used in an attempt to evaluate a program of vocational education from a societal point-of-view. The benefits would be the sum of the present value of future additional income accruing to all students over what their future income would have been had they not participated in the program. From the societal viewpoint future additional income would include additional taxes paid. Many of the benefits often attributed to vocational education, such as reducing unemployment or meeting

critical manpower needs, resolve into additional income for program participants. Some benefits as seen by those who support particular programs would not enter into a total, societal viewpoint. For example, a program of vocational education might attract a firm to a particular locality, but this would not be a benefit from a national point-of-view as the firm would have located somewhere else. The difficulty, of course, is determining what part of future gross income is in fact attributable to the training received. There are two possible approaches: first, to identify individuals who did receive a particular type of training and compare their income experience with a control group of similar individuals who did not receive that training; second, to develop a formal model which would predict the additional income which will accrue to students in a particular program. The difficulty with the first approach is that it only permits programs in the distant past to be evaluated; with the second approach detailed, but necessarily conjectual, predictions of the future would have to be made requiring a considerable research effort. The rate of interest used in discounting future dollar amounts of benefits or costs when making the societal judgment may well differ from that used by individuals. There has been a long controversy about the appropriate rate of interest to use in benefit-cost analyses of water resources projects - the most commonly mentioned rate in the current literature is 5% or 6% rather than the rate of interest of U.S. Government bonds or an arbitrarily lower rate.

On the cost side out-of-pocket and opportunity costs borne by students must also be considered in the societal judgment. Out-of-pocket expenses to the student can be reduced by making a public program free of tuition and by providing transportation, though some such costs are likely to remain. Opportunity costs may be valued quite differently by society than by the individuals involved. For example, if individuals have to forego welfare, unemployment or other transfer payments by enrolling in a program of vocational education they will treat these foregone payments as opportunity costs while from the societal viewpoint they will equal zero since they transfer income from one set of individuals to another. (The eliminated administrative costs involved in making such transfer payments could be treated as a negative opportunity cost.) If individuals were to forego criminal activity, the receipts from which they value positively, society would consider those receipts as negative opportunity costs. When individuals forego activity which is not income generating in the usual sense, such as housewifery or leisure, some societal estimate of the dollar value of such activity sould have to be included in opportunity costs.

The next element of cost to be considered is capital costs. A vocational education program may require additional building space and specialized equipment. If a program, say a night school course, uses space and equipment which is already available and would be unutilized otherwise no cost should be assigned to the program on this account. Operating costs would be primarily teacher

salaries and supplies but might also include utility and maintenance outlays which would not have to be made if the vocational education program were not in effect. As with dollar measures of benefits, costs which accrue in future years must be discounted in deriving the present value of total costs.

The ratio of benefits to cost, thus derived, could be called the societal benefit-cost ratio of a particular program of vocational education. It does not account for benefits which cannot be measured in terms of the increased future income of students who participate in the program. Even though these intangibles have been excluded from the analysis a considerable research effort would have to be mounted in order to apply this technique to an actual situation. Much data would have to be assembled in each case. Some pilot projects, however, are underway in which this method of analysis is being used. The difficulties involved make it impractical to undertake strict benefit-cost analyses of vocational education on a widespread scale. Hence it appears reasonable and desirable to develop a variant from of benefit-cost analysis which would require minimum amounts of data and which could be used at the local level by those who have the primary responsibility for evaluating and planning vocational education. The following section presents such a schema.

A Variation of Benefit-Cost Analysis:

The essential element is this variation of benefit-cost analysis is the treatment of benefits as an unknown in an equation which includes the known (or estimated) costs of a particular vocational education program, the number of students in (or graduates of) the program and an arbitrarily selected benefit-cost ratio. In essence this technique calls for the person making the analysis to ask, what does the amount of benefits in terms of additional future income of students trained in the program have to be, given the costs of the program, so that the ratio of benefits to costs would at least equal the predetermined level. The derived amount of benefit can be expressed in terms of average annual additional earnings per student. A judgment is then made as to the reasonableness of the expectation that the students will indeed be able to earn at least the specified amount of additional annual income as a result of being trained in the particular program. This judgment would have to be made with reference to the actual experience of graduates from the program, advice from employers, the opinion of the U.S. Employment Service, etc. In many cases the answer will be clear-cut; even in the doubtful cases it is easier to determine whether of not students can be reasonably expected to earn some specific amount (or more) of additional income than to estimate precisely the amount of additional income which will in fact be earned. This technique is spelled out more precisely in the Appendix. What follows is not meant to suggest that this method of analysis is the only one which might be used to evaluate existing programs or to plan new ones or that economics should be the only consideration. Some of the limitations to this approach are explored in the fourth section of this paper.

Here the objective is to present a viable means by which economic factors, benefits and costs as measured in dollar terms, can be included in the total process of evaluation and planning.

As a hypothetical example of how this technique might be used to evaluate an existing program consider one in which ten students graduate per year, operating cost (calaries, supplies,etc.) are $15,000, capital cost (the current value of the equipment and the space being used*) are $25,000, and out-of-pocket expenses borne by students and opportunity costs are zero on the assumption that in the absence of this program they would be enrolled in some other program rather than being members of the labor force. If it is further assumed that the program will last ten years and that five parcent is an appropriate interest rate to use then the total cost per student is $1,823, ($15,000 + .1295 ($25,000)] ÷ 10; .1295 is an annuity whose present value is 1, taken from interest tables for a 5% rate of interest and a ten year time period). For the benefits of the program to be just equal to the costs the average student would have to earn additional future income which had a present value of $1,823. If some sssumption is then made about the length of time over which students could be expected to earn additional income due to their training, say twenty yeaxs, this figure can be converted into an average annual amount of additional future income by dividing by a factor (12.46) equal to the present value of an annuity of one dollar per year for twenty years, again at a five percent rate of interest. On these assumptions for the benefits to just equal costs students would have to earn on the average $146 of additional income per year for twenty years. (For benefits to be double the costs students would have to earn on the average $292 per year, etc.) To complete the evaluation a judgment must be made as to the reasonableness of expecting that students will indeed earn at least $146 per year over and above what they would earn if they had not received the training. If that judgment results in a positive answer then it can be said with confidence that the benefits at least are equal to the cost. For any one program this analysis can easily be repeated using higher ratios, though as the ratio used increases one would be less and less confident that extra earnings will indeed equal the prescribed figure.

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*Estimating the value of the space being used may be particularly difficult. As a general principle the appropriate figure is the value of the space in its best alternative use. If in the absence of the particular program the space would go unused then the appropriate value is zero. In a case where the space could be used as a regular classroom and the building will last another ten years before having to be replaced the value of the space would be equal to the cost of building a new classroom amortized over the life of the new classroom to arrive at an annual figure which would then be multiplied by ten.

A more interesting application of this variation of benefit-cost analysis concerns allocating newly available resources among proposed alternative vocational education programs. Consider for example the hypothetical case of a school board and superintendent of schools faced with the problem of choosing among several proposals for new vocational education programs. Choices have to be made as the amount of funds available for funding the new programs is is limited. The basic procedure would be to pick some cut-off benefit-cost ratio, say 3:1, and calculate for each of the proposed programs the average annual amount of additional income which students would have to earn in order for benefits to be three times the costs involved. Then ask whether in each case it is reasonable to assume that the students will indeed earn at least the specified amount. When this is done some programs may be ruled out because of the unreasonableness of the assumption that students would be able to achieved the required amount of additional income. If the cost of all the programs which qualify on these grounds still supersedes the funds available then the analysis would simply be repeated using progressively higher cut-off benefit-cost ratios until a set of programs remained which just absorbs the available funds. Conversely if too few programs qualify when the 3:1 ratio was used progressively lower cut-off ratios would be used. If at a ratio of 1:1 the cost of the qualifying programs still does not absorb the available funds it would be clearly necessary to find some new and better proposals or spend the funds on something else. In one respect using this technique for planning is easier than using it for evaluating existing programs, namely the matter of estimating capital costs. When a program is first introduced the cost of equipment and building space can be more precisely determined, especially when the equipment must be purchase and an additional building constructed.

Each proposal would have to include an estimate of the number of students who would enroll in the program. The mere ability of the program to accomodate say twenty students per year is insufficient. There would have to be the further assurance that twenty students will in fact enroll. A program which might well qualify at a given benefit-cost ratio on the basis of the number of students which could be accomodated might not qualify if a smaller number of students actually enrolled. Prospective students might not be interested in acquiring the particular skills being taught or may think the jobs being trained for lack sufficient status.

IV

Some Limitations of Benefit-Cost Analysis

There are several important limitations attached to the use of benefit-cost analysis. Without specifying a specific case it is impossible to even list all the relevent limitations; what follows is a discussion of four issues which are likely to be applicable in all cases: 1) the treatment of benefits which cannot be measured in dollar terms, 2) the comparison of monetary benefits among different individuals, 3) the search for the best possible programs, and 4) the treatment of benefits which accrue outside a particular community.

Any two existing or proposed vocational education programs in a particular school system, which are compared on the basis of the techniques outlined above, will undoubtedly have a different set of benefits which cannot be expressed in terms of individual income. If these intangible factors - such as the possible contribution of the programs to the local economy, encouraging students to stay in school, or providing students with skills which will enable them to make "better" use of their leisure time - are thought to be important by local decision makers a final choice among several proposed programs which qualify at some cut-off benefit-cost ratio greater than 1:1 could be made on the basis of their respective intangible benefits. An existing program which met the benefit-cost test at some low ratio, say 1:1, might not be discontinued in favor of a new program, which could reasonably be expected to produce benefits equal to three times the costs involved, due to overriding intangible factors.

This method of analysis treats a dollar of additional income received by one individual as precisely equal to a dollar of additional income received by some other individual. Economists have never been able to develop an analytical method for assessing the value which one individual or another places on an extra dollar of income. Yet in several instances public policy is based on the assumption that an extra dollar of income is valued less by the rich man and more by the poor man - witness progressive income taxation and welfare programs which involve income redistribution. Suppose, for example, that one proposed program of vocational education would be expected to increase the average annual income of its graduates by $1,000 per year and an alternative program with the same cost would increase the average annual income of its graduates by $2,000. On the basis of the techniques discussed above the second program would be preferred. But suppose the second program involves training good students at the post-high school level who would in the absence of the advanced training be expected to earn an average annual income of $10,000 and that the first program involves training potential drop-outs from an urban slum who would in the absence of that training be expected to earn an average annual income of $3,000, due to low wage rates and frequent and protracted periods of unemployment. On public policy grounds, however, the first program might be preferred. In this instance benefit-cost analysis does not provide any basis upon which to judge the value of

the $2,000, or 20% increase in income, in the second case with $1,000, or 33% increase, in the first program. Indeed by implicitly avoiding this problem, use of benefit-cost analysis as the sole method of evaluating and planning would lead to an overall program of vocational education which would not be judged by most people as representing the best possible use of the resources devoted to this segment of the public sector. In a situation like this the techniques described above might still be used to select the best among several alternative programs designed to meet the problems of the disadvantaged urban youths and to choose the best programs for the good students taking post-high school training. The allocation of funds between these two general types of vocational education would then be made on the basis of more "political" factors.

Using the variation of benefit-cost analysis presented above does not guarantee that the best possible programs will be introduced. No method has been suggested which would aid educators at the local level in seeking out the best possible programs, but rather a technique was described for choosing among the good, bad, and indifferent programs which are in fact proposed. Similarly the attention of local decision makers would not be directed toward possibly superior programs outside the traditional scope of vocational education. Using benefit-cost analysis to evaluate vocational education cannot per se provide a basis upon which to determine the portion of the total education budget which should be allocated to vocational education.

Nothing has been said above about the location of the employment from which former students will gain additional income as a result of their training. In the analytical framework which has been presented no distinction was made concerning the future location of students - a dollar earned anywhere is treated in precisely the same way as a dollar earned in the local community where the programs are being offered. If local decision makers conclude that it is reasonable for students to earn the requisite amount of additional future income only by migrating to other job markets they should have evidence that students are indeed willing to move. On the other hand there is the danger that, in the process of planning or evaluation, a particular program will be ruled out on the parochial grounds that local labor market conditions are such that it is not reasonable to expect that students will be able to earn the requisite amounts of future income. The rejection of such a program might lead to the continuation at the local level of programs which, from the aggregate or national viewpoint, are not as desirable as possible alternatives.

Despite these and other possible limitations it seems desirable to use benefit-cost analysis in evaluating and planning vocational education at the State and local levels. Techniques have been described in this paper which require neither large amounts of data nor particularly safisticated research efforts. If used in conjunction with other, more subjective criteria they could lead to a more effective allocation of those resources made available for vocational education. As a minimum these methods of analysis would identify current or proposed programs where the probable economic benefits do not warrant the actual or prospective expenditures.

APPENDIX

In this appendix the methods of analysis discussed in section III are presented in a more rigorous manner. In what follows, various symbols will be used to signify particular parameters in the different equations; these symobls are defined below:

R_{tj} = additional income net of taxes in year t expected by individual j to accrue as a result of completing a program of vocational education.

$\bar{R}_{tj}$ = additional gross income in year t expected by society to accrue to individual j as a result of completing a program of vocational education.

i_j = rate of interest used by individual j to discount expected future additional income.

$\bar{i}$ = rate of interest used by society to discount expected future additional income and costs.

O_j = opportunity costs as seen by individual j.

$\bar{O}_j$ = opportunity costs for individual j as seen by society.

C_j = cost of a program borne by individual j including tuition, transportation, etc.

$\bar{C}_t$ = operating cost of a program in year t borne by society.

$\bar{K}$ = capital costs of a program borne by society.

n = number of years over which additional income is expected.

p = number of years over which a program is in operation.

m = number of program graduates per year.

$a_{\bar{i}p}$ = annunity whose present value is 1, for interest rate $\bar{i}$ and number of years p.

$A_{\bar{i}n}$ = present value of an annuity for interest rate $\bar{i}$ and number of years n.

Σ = summation.

o = average value.

An individual, j, would examine the ratio, B_j of: 1) the present value of the expected additional income attributable to the training received in each year, R_{tj}, up to n years to, 2) the opportunity and out-of-pocket costs (assumed to accrue only in the first year) of the program.

(1)
$$B_j = \frac{\sum_{t=1}^{n} \frac{R_{tj}}{(1+i_j)^t}}{O_j + C_j}$$

If the ratio B_j is greater than one, the highest among all alternative programs, and consistent with his occupational preferences he will enroll in the program.

From the societal viewpoint the benefit-cost ratio ($\bar{B}$) for the same program, being evaluated as of a particular year (t=o), would equal the ratio of the present value of additional future income, summed up for all m individuals graduating from the program during that year to total cost, consisting of: (1) the sum of the societal valuation of opportunity costs for the m individuals, (2) the sum of out-of-pocket costs borne by the m individuals, (3) the operating costs of the program in year t=o, and (4) the portion of capital costs attributable to that one year.

(2)
$$\bar{B} = \frac{\sum_{j=1}^{m} \sum_{t=1}^{n} \frac{\bar{R}_{tj}}{(1+\bar{i})^t}}{\sum_{j=1}^{m} \bar{O}_j + \sum_{j=1}^{m} C_j + \bar{C}_{t=o} + a_{\bar{i}\rho} K}$$

As explained in the text, societal estimates of particular parameters may be quite different from individual estimates which appear in equation (1).

Estimating the various parameters in the previous equation would require a great deal of data and a considerable research effort. The alternative method of benefit-cost analysis which, as described in the text, treats benefits as an unknown can be specified as follows: A cut-off benefit-cost ratio, $\hat{B}$, is selected. The unknown level of benefits, X, is equivelent to the present value of future additional income earned by the average program graduate (equation 3). Costs are expressed on an average per pupil basis.

(3)
$$X = \sum_{t=1}^{n} \frac{\bar{R}_{to}}{(1+\bar{i})^t}$$

(4) $$\hat{B} = \frac{X}{\bar{O}_o + C_o + \frac{\bar{C}_o + a_{ip}K}{m}}$$

Equation (4) is solved for X which can then be converted via equation (5) into a value for Y which is the average annual amount of additional future income which over n years would have a present value of X.

(5) $$Y = \frac{X}{A_{in}}$$

As an example of the use of this variation of benefit-cost analysis in planning vocational education consider a school district superintendent, who in recognition of the scarcity of funds available for new vocational education programs, begins with a cut-off benefit-cost ratio of 3. He uses a 5 percent rate of interest and a 20-year time horizon in making his analysis. In terms of equation 4 above, these rules-of-thumb can be stated as:

$\hat{B} = 3$

$\bar{i} = 5\%$

$t = 20$

One of the presumably many proposals for new programs of vocational education which are submitted to him for approval has the following characteristics:

Capital costs	$K = \$100,000$
Annual operating costs	$\bar{C} = \$ 20,000$
Average number of graduates per year	$m = 20$
Number of years the program will last	$p = 10$
Average opportunity and out-of-pocket cost per graduate	$(\bar{O}_o + C_o) = \$2,000$
$t = 20$, $i = 5\%$, implies	$A_{in}^{-} = 12.46$
$p = 10$, $i = 5\%$, implies	$a_{ip}^{-} = .1290$

Equation 4 is solved for X, the present value of the future additional income of the typical graduate which would be sufficient for a benefit-cost ratio of 3 to pertain for the proposed program:

$$3 = \frac{X}{2000 + \frac{20{,}000 + .1290\ (100{,}000)}{20}}$$

$X = \$10{,}935.50$

The value derived for X is then converted into average annual future additional income, Y.

$$Y = \frac{10{,}935.50}{12.46}$$

$Y = \$887$

The superintendent then ask, "Is it reasonable to suppose that the graduates of this program will indeed earn additional income at least equal to $887 per year for 20 years?" In answering this question, he may turn to local employers, USES, etc. If the answer is positive the program qualifies for support, if negative the program would be rejected. Similar analyses are made for all other proposed programs. If too many programs qualify at the 3:1 ratio for support, given the available funds, the analysis would be repeated for all proposals which qualified using say a 4:1 ratio. If too few programs qualify all programs would be reevaluated using say a 2:1 ratio.

The following table shows values for Y when alternative perameters are used in equation (4) given the stated values in the above example for the remaining parameters:

Alternative value for the specified perameter	Value of Y
m = 10	$1,275
n = 30	746
i = 3%	723
i = 8%	1,144
$(\bar{O}_o + C_o)$ = $1,000	637
$(\bar{O}_o + C_o)$ = 0	396
p = 20	819
t = 30	712

$t = 10$	1,418
$\hat{B} = 1$	293
$\hat{B} = 2$	586
$\hat{B} = 4$	1,010